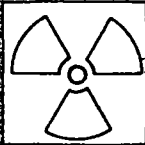


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# NUCLEAR RESOURCE DEVELOPMENT



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Public Health Service

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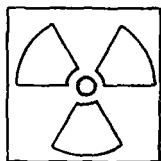
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CONFIDENTIAL



HEALTH HAZARDS  
RELATED TO  
**NUCLEAR RESOURCE  
DEVELOPMENT**  
ON INDIAN LAND

A REPORT

NOVEMBER 1982

DEPARTMENT OF HEALTH & HUMAN SERVICES  
Public Health Service  
Health Resources and Services Administration  
Indian Health Service  
Office of Environmental Health



THE SECRETARY OF HEALTH AND HUMAN SERVICES  
WASHINGTON, D.C. 20201

APR 27 1983

The Honorable George Bush  
President of the Senate  
Washington, D.C. 20510

Dear Mr. President:

Enclosed for your consideration is the report entitled "Health Hazards Related to Nuclear Resource Development on Indian Land". This report was prepared in accordance with the requirements of Section 707(a) of the Indian Health Care Amendments of 1980 (P.L. 96-537).

This report summarizes the development of the nuclear industry on Indian land, the adverse health effects to Indians associated with such development, and the actions taken in response to the potential health problems resulting from exposure to radiation. The approximate cost to prepare this report was \$10,175.

Sincerely,

*Margaret M. Heckler*  
Margaret M. Heckler  
Secretary

Enclosure



THE SECRETARY OF HEALTH AND HUMAN SERVICES  
WASHINGTON, D.C. 20201

APR 27 1983

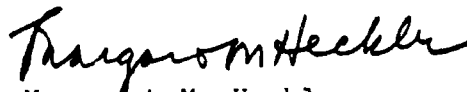
The Honorable Thomas P. O'Neill, Jr.  
Speaker of the House of Representatives  
Washington, D.C. 20515

Dear Mr. Speaker:

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Sincerely,

  
Margaret M. Heckler  
Secretary

Enclosure

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## ■ EXECUTIVE SUMMARY

Section 707(a) of the Indian Health Care Amendments of 1980, P.L. 96-537, required that a study be conducted of the health hazards to Indians as a result of nuclear resource development on or near Indian land. Because the funds authorized for the study were not appropriated by Congress and because substantial documentation on the subject of radiation already existed, the Indian Health Service (IHS) reviewed the existing literature and prepared a report. This report summarizes the development of the nuclear resource industry on Indian land, the adverse health effects to Indians associated with such development, and the action taken in response to the potential health problems resulting from exposure to radiation.

Each individual in the United States is exposed to radiation from both natural and man-made sources. Nuclear power plants contribute little to an individual's exposure, and while radioactive waste may be transported through Indian land, no disposal sites are located on Indian land. The major sources of radiation on Indian land are uranium mining and milling activities and abandoned uranium mill tailings piles.

Most of the nation's uranium resources are located in the western United States and sizable deposits are found on Indian land. Early mining operations were not well regulated and miners were exposed to high levels of radiation. A number of these miners, some of whom were Indian, later developed lung cancer. Improvements in regulations and enforcement have resulted in better conditions in the mines and have lowered miners' exposure. However, existing monitoring techniques measure levels of radon present in the mines and not radon exposure to the individual. Until research is complete on a personal dosimeter for radon, it will not be possible to measure an individual's exposure with the degree of accuracy desired. Likewise, current milling operations, although well regulated, contribute radiation exposure to both workers and the regional population where the mill is located. Based on risk estimates developed for the milling industry, this exposure can be estimated to result in less than two premature deaths/year from cancer nationwide.

Numerous studies have been conducted of the five abandoned uranium mill tailings piles located on Indian land. Remedial action is now planned by the Department of Energy as a result of P.L. 95-604, The Uranium Mill Tailings Radiation Control Act of 1978, and is scheduled for completion by 1989. While no health effects or water contamination have been observed, radiation levels at the piles exceed background levels and may be cause for concern to persons living close to or working at these sites.

Although other health problems of the Indian population present substantially more risk of disease and/or death than radiation, the IHS is still concerned about the potential adverse health effects of radiation and will continue to provide education about radiation in order that radiation and its effects are better understood. In addition, the IHS will continue to work with all government and private agencies with responsibility in radiation matters to ensure that legislation and regulations regarding radiation are properly implemented and monitored on Indian land in order to reduce the level of radiation exposure to the worker and the general population.

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## ■ INTRODUCTION

### **Purpose of the Study**

Considerable concern has been expressed about the possible adverse effects on the health of Indian people as a result of the mining and processing of uranium deposits in the western United States (U.S.). This is evident from the number of studies performed and the plans and efforts made to correct potentially hazardous conditions. In the past, the division of responsibility for radiation activities within the Federal Government and the lack of adequate industry regulation at the onset of mining activities led to a somewhat fragmented approach to the situation. This has changed significantly with the advent of standards and regulations for the uranium industry and a more clear, although not complete, definition of responsibility among Federal agencies.

Enactment of P.L. 96-537, The Indian Health Care Amendments of 1980, on December 17, 1980, added impetus to an already increasing concern. A new section, Section 707, "Nuclear Resource Development Health Hazards," was added. Subsection (a) of Section 707 required that a study be conducted of the health hazards to Indian miners and Indians living on or near Indian reservations, and in Indian communities, as a result of nuclear resource development. The amount of \$300,000 was authorized for the study; however, the funds were not appropriated by Congress.

### **Extent of the Study**

Initial efforts by the Indian Health Service (IHS) to address the requirements of Section 707 included the identification of other agencies which were involved in radiation activities. This was accomplished through the Subcommittee to Coordinate Radiation Activities of the Department of Health and Human Services (HHS), chaired by the Director of the Bureau of Radiological Health, Food and Drug Administration (FDA); and the Interagency Radiation Research Committee, chaired by the Assistant Secretary for Health, HHS. As a result of the meetings of these two committees, contacts were made with Federal departments and agencies which dealt with radiation including the Nuclear Regulatory Commission (NRC), the Department of Energy (DOE), the Environmental Protection Agency (EPA), the Department of Defense as well as two other Public Health Service (PHS) Agencies, the National Institutes of Health and the Centers for Disease Control (CDC).

The consensus of these two committees was that the adverse health effects of radiation exposure have been extensively studied and considerable data on the subject are available for analysis. Because the biological effects of radiation apply to all ethnic

groups, including Indians, these committees concluded that existing reports and studies could be utilized to address the issues raised in Section 707. Based on these conclusions, the IHS reviewed existing literature and prepared a report which summarized the development of the nuclear resource industry on Indian land, the adverse health effects to Indians associated with such development, and the action taken in response to the potential health problems resulting from exposure to radiation.

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## ■ RADIATION AND ITS EFFECTS

### **What is Radiation?**

Radiation is a property of the smallest particles which make up all matter in the universe, atoms. The atom is made up of a nucleus which contains neutrons and protons and orbiting particles called electrons. The stability of the atom is determined largely by the ratio of neutrons to protons within the nucleus. If an increase in the number of neutrons occurs, an unstable energy balance between neutrons and protons within the nucleus results. This imbalance will be corrected by the spontaneous emission of energy and/or particles from the nucleus. This process is known as radioactivity.<sup>1</sup>

Radioactive atoms spontaneously emit some type of ionizing radiation energy. Ionizing radiation affects cells by the action of these charged particles which dislodge electrons from atoms in the material irradiated. By this mechanism, energy is transferred from the radiation to the material. However, the disposition of energy is not uniform, so the energy absorbed by the material varies.

Not all radiation is the same. The velocity with which these particles leave the nucleus determines the distance that they will travel in any substance; and the size of the particles plays a role in their ability to penetrate matter. Alpha particles are large, heavy, and slow moving. They lose their energy rapidly so they have a limited range of 6-7 centimeters in air and cannot penetrate the outer layer of dead skin. Beta particles are smaller, move at a higher rate of speed, and have a range of several meters in air. A thin sheet of metal is necessary to stop beta particles. Gamma and x-rays are not particles, they are rays possessing no mass or electrical charge, which travel at the speed of light and possess a great penetrating ability.<sup>2</sup> Their range is dependent on their energy which in turn determines the denseness of the material required to attenuate the rays.

### **Man's Exposure to Radiation**

Natural background radiation remains the greatest contributor to the radiation exposure of the U.S. population today.<sup>3</sup> There are three components to background radiation: terrestrial radiation, resulting from the presence of naturally occurring radionuclides in the soil; cosmic radiation, arising from outer space; and naturally occurring radionuclides in the human body.

The U.S. can be divided into three areas from the standpoint of terrestrial radiation: the Atlantic and gulf coastal plains; the northeastern, central, and far western portions; and the Colorado

plateau area. Radiation levels are highest in the Colorado plateau, primarily because of the presence of large uranium deposits. In cosmic radiation altitude is the determining factor, so persons living at the higher elevations are exposed to higher doses. Naturally occurring radionuclides in the human body result from the ingestion and inhalation of these materials in air, foods, and water. The total exposure from background sources results in an average dose of 0.1 rem/year (yr.)\* for each individual.<sup>4</sup>

The largest source of man-made radiation exposure of the U.S. population is from x-rays used for medical diagnosis and therapy.<sup>5</sup> This is an area where efforts are underway to decrease the individual's average 0.09 rem/yr. dose by improved monitoring of equipment, by more selective usage of x-ray examinations, by the use of improved technology to decrease dose, and by continued education of the technician.

An additional source of radiation exposure is occupational. This includes all occupations in which radioactive material is produced or used such as mining and milling, industrial radiography, nuclear power plants, research, and medicine. Individuals in these occupations receive doses which vary from an average of 0.16 rem/yr. for workers at nuclear fuel processing and fabrication plants to 0.7 rem/yr. for workers at commercial power plants.<sup>6</sup> The average exposure of uranium miners who worked in underground mines is 2.9 Working Level Months/year (WLM/yr.)<sup>7\*\*</sup>. These values are within the current occupational exposure limit of 5.0 rems/yr. for whole-body radiation dose and 4 WLM/yr. for radon daughter (decay products of radon gas) exposure to the lungs. At the same time, the existence of such occupations contributes approximately 0.0008 rem/yr. to the average individual's dose.

Exposure can also occur as a result of an accident involving a leak from a nuclear power plant or a spill of transported radioactive material. While it is not possible to place a value on the level of exposure which would result from an accident, in most instances the population affected would be limited. In addition, emergency procedures serve to limit the duration of any exposure, thus minimizing the actual amount of radiation exposure.

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\*rem is the unit of measure for radiation dose and relates to the biological effect of the absorbed radiation.

\*\*WLM is used to describe exposure to radon daughter environments. It represents the potential alpha energy present per liter of air, a working level, multiplied by time, in this instance one month or 170 hours.

The average individual in the general population receives a radiation dose of about 0.2 rem/yr. from non-occupational sources. This includes 0.1 rem of background radiation; an amount which must be deducted when calculating dose from non-natural sources.

### **Effects of Radiation Exposure**

Some of the health effects that exposure to radiation may cause are cancer (including leukemia), birth defects in the children of exposed parents, and cataracts. These effects (with the exception of genetic effects) have been demonstrated in studies of medical radiologists, uranium miners, radium workers, survivors of atomic bombs, and radiotherapy patients who received high radiation doses. Genetic effects, while observed in laboratory animals, have not been observed in any of the studies of exposed humans.<sup>8</sup>

It is known that radiation can cause chromosomal damage in a cell which may lead to abnormal growth patterns; but other processes by which radiation causes cancer are not well understood. One theory holds that radiation activates an existing virus in the body which then attacks normal cells causing them to grow rapidly. Another holds that radiation reduces the body's normal resistance to existing viruses which can then multiply and damage cells. However, cancer does not always develop as a result of radiation exposure.

The American Cancer Society estimates that 25 percent (%) of all adults in the 20-65 year age bracket will develop some type of cancer at some time from all possible causes such as smoking, food, alcohol, drugs, air pollutants, and natural background radiation.<sup>9</sup> It is estimated that an occupational radiation dose of 1 rem over a lifetime will increase the cancer rate to 25.03%.<sup>10</sup> This represents an increase of 3 cases in 10,000 workers.

Another way to look at risk is to compare life expectancy lost from radiation induced cancer with other health risks. For example, smoking 20 cigarettes/day results in an estimated loss of life expectancy of 2,370 days; auto accidents result in a loss of 200 days; natural background radiation, 8 days; medical x-rays, 6 days; and an occupational dose of 1 rem, 1 day. Based on this, the worker in the nuclear industry, who is currently exposed to an average dose of 0.65 rem/yr., would experience a loss of life expectancy of 20 days over a lifetime of working in the nuclear industry.<sup>11</sup> However, for uranium miners the loss is 45 days.<sup>12</sup>

As early as 1879, lung cancer was diagnosed among uranium miners in Germany. Studies in Germany and Czechoslovakia covering the period

1875-1930 reported that 40% of the deaths among miners of uranium-bearing ores were due to cancer of the lung. In 1939, it was reported that the lung cancer mortality among miners in Czechoslovakia was markedly higher than that of males in Vienna, Austria.<sup>13</sup> Until 1951, radon in the air was the presumed source of radiation which led to the development of lung tumors. However, it was shown that radon daughters would attach to dust particles and that they would radiate the lung tissue resulting in a dose about 20 times higher than that from inhaled radon.<sup>14</sup>

The PHS, in cooperation with the Atomic Energy Commission (AEC) and the State Health Departments of Colorado, Utah, Arizona, and New Mexico, began environmental studies in uranium mines in 1949. These were followed a year later by medical studies which continued for 10 years. The environmental studies indicated that miners, who mined prior to 1953, may have received an average dose to their lungs of 2,000-3,000 rems over a 10 year period.<sup>15</sup> Furthermore, the preliminary conclusions, based on a review of the medical records, indicated a higher number of lung cancer deaths than would normally be expected.<sup>16</sup>

These findings were substantiated in a 1974 study which also addressed the relationship of radiation caused lung cancer and smoking. It had been suggested in a 1971 study that the latent period of radiation caused lung cancer was longer in non-smokers as compared to smokers.<sup>17</sup> The results of the 1974 study were compatible with this suggestion as the latent period for non-smoking or lightly smoking Indians was 19.1 years as contrasted with 13.7 years for a group of heavy smoking white uranium miners dying of lung cancer.<sup>18</sup> A 1979 study lent further support to the synergistic effect of smoking on the incidence of lung cancer among uranium miners.<sup>19</sup>

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## ■ IMPLICATIONS OF NUCLEAR RESOURCE DEVELOPMENT ON INDIAN LAND

### Development of the Uranium Industry

Uranium has been mined in the U.S. since the turn of the century. However, it was not until the 1940's, and the development of nuclear energy, that the demand for uranium outpaced the production from known deposits in the U.S. The passage of the Atomic Energy Act of 1946 led to greater emphasis being placed on the discovery and development of new sources of uranium.<sup>20</sup> At the same time, improvements in technology allowed the utilization of lower grade ores from existing mines than previously had been considered practical.

The Colorado plateau was rich in uranium and this resulted in a boom of the uranium industry in that area. The AEC encouraged mining activities through guaranteed prices for ore. Mill process development programs were sponsored by the Manhattan Engineering District (MED), and later by the AEC, through contracts from 1944 through 1958. From the 1940's to the mid-1960's, the MED, and then the AEC, were the only purchasers of uranium in the U.S. In 1957 the AEC determined that existing contracts would meet uranium ore requirements through 1966. As a result, the AEC withdrew its offer to buy uranium from any ore reserves developed in the future. A number of mills were therefore forced to shut down at the expiration of their contracts.<sup>21</sup>

The period from 1967 to 1970 witnessed a considerable reduction in the number and production rates of active uranium mills. There was a resurgence during the 1970's as the nuclear power industry grew. However, demand for uranium has been somewhat less than anticipated because of a decrease in the need for electricity from nuclear powered generating plants and the public's concern about radiation. For example, new deposits in the Grants, New Mexico area have been readied for mining, but production has been delayed. Nonetheless, the NRC, the regulatory successor to the AEC, has projected an increase of over 100% in the amount of uranium ore needed by the year 2,000.<sup>22</sup>

### Sources of Radiation Concern

Uranium Mining and Milling - Occupational exposure to radiation occurs at all steps in the uranium production process. Radiation is present as alpha, beta, and gamma radiation. However, it is the alpha radiation from radon and its daughters and gamma radiation from the decay products of uranium which give cause for concern. The chemical toxicity of uranium is also cause for concern. While conditions in uranium mines have improved over the years, the early miners were exposed to high levels of radiation. Studies showed that adequate ventilation, combined with other dust control

measures, is capable of substantially reducing or eliminating radioactive dust and other dust hazards.<sup>23</sup> Better mining conditions and the establishment of exposure standards have served to reduce the radiation exposure to miners.

The uranium boom of the 1950's left the waste of the milling process, mill tailings, as a legacy. These mill tailings contain 85% of the original radioactivity present in the uranium ore<sup>24</sup> and are a source of possible radiation exposure. Five such piles are located on Indian lands in Riverton, Wyoming; Shiprock, New Mexico; Mexican Hat, Utah; and Monument Valley and Tuba City, Arizona.

The original agreements between the AEC and the milling companies did not address the question of mill tailings disposal. As early as 1963, the problem of disposal was raised, but it was not until passage of The Uranium Mill Tailings Radiation Control Act of 1978, Public Law 95-604, that a comprehensive effort was undertaken to resolve the problem. In the intervening years, the PHS was involved in surveys of these piles and assisted in attempts to stabilize them.

Alpha and gamma radiation are emitted from the mill tailings waste at these inactive sites. The amount of radiation to which one is exposed because of the tailings is a function of one's proximity to the site and the duration of exposure. Four of the sites on Indian land are located in sparsely populated areas. The exception is Shiprock, where the risk estimate to the population living within six miles of the site can be estimated to be 3 additional cancer deaths over 100 years.<sup>25</sup> While this number appears small, it is three more than would be expected if there were no mill tailings present.

Concerns extend beyond the piles themselves and their locations. Mine waste and mill tailings used as fill or as building materials present some risk. It has been estimated that houses constructed on land containing a radium concentration of 5 pCi/g may result in a lifetime risk of 2.5 cancer deaths per 100 persons.<sup>26</sup> On the Navajo Reservation, a number of homes were constructed using such materials. Some of these homes have been replaced by the Bureau of Indian Affairs. The remaining homes are being resurveyed to determine if total or partial replacement is needed.

More recently concern has been expressed about the effects of uranium mining and milling on the quality of ground water. In the process of uranium exploration, holes are drilled to map the uranium deposit. When this is done, water bearing formations are entered and the possibility of ground water contamination exists. An additional concern was that water seeping from mill tailings ponds might contaminate the ground water. As early as 1957, studies were carried out in the Grants Mineral Belt of New Mexico to ascertain if

water quality was being affected. These studies suggested that some wells were contaminated by toxic substances from the tailings; however, only one of the 71 ground water samples was found to exceed the EPA standard for radium 226 in drinking water.<sup>27</sup> The analysis of water samples taken from the five inactive mill tailings sites located on Indian land showed that levels of radium 226 were also less than the EPA standard. This data, together with a study in Illinois,<sup>28</sup> indicates that the movement of radionuclides in soil is limited. However, other toxic substances migrate through the soil at a more rapid rate which could lead to ground water contamination. In order to limit such contamination, the EPA has concluded that some controls on seepage from mill tailings ponds are warranted.<sup>29</sup>

Nuclear Power Plants - The nuclear power industry has one of the better safety records in industry. Accidents do occur, such as Three Mile Island, but the health effect on the population has been minimal, if any.

An accident at the Prairie Island Nuclear Facility in Minnesota in 1979 pointed out a gross deficiency in the facility's emergency plan. The Prairie Island Sioux Reservation is located adjacent to the facility yet its residents were not informed of the accident until notified by IHS. Subsequent to the accident, meetings were held with the State, plant officials, and the community to discuss the inclusion of the Indian community in the emergency plan. A system of communication now exists and the community has had an opportunity to comment on the plan. This is not a problem elsewhere because NRC has determined that an emergency plan is required for the public within a 10 mile radius of any nuclear power plant, and none of the other four plants located near Indian land are closer than 20 miles. This holds true for a fifth facility which is presently under construction.

Radioactive Waste Disposal - There are three commercial dumps for low level radiation waste in the U.S. One of these is located in Washington State about 30 miles from the Yakima Indian Reservation. While tribal leaders have expressed some concern about the possibility of contamination of the environment as a result of seepage of this waste into the ground water and runoff into the Columbia River, routine monitoring by the State has not detected any problems.

High level radioactive waste, such as spent fuel rods from nuclear power plants, is currently stored on the grounds of the generating facility. The storage sites are strictly regulated and routine monitoring is conducted to ensure compliance with these regulations. However, concerns about the potential problems of high

level radioactive waste will remain until a permanent solution is found for the safe disposal of such waste.

Transportation of low level radioactive waste across Indian land by road and rail, and the possibility of accidents, is a concern of Indian people. The movement of radioactive waste is strictly regulated by the Department of Transportation and emergency plans exist to deal with an accident should one occur.

Radiation in Water - Radionuclides can be found in water in many parts of the U.S. and have been found in some water sources on Indian land. These radionuclides occur naturally and are unrelated to nuclear resource development.

### **Health Risks to Indians from Radiation Exposure**

The major health risk from radiation exposure to the Indian population is the development of lung cancer as a result of uranium mining. Studies conducted from 1950 to 1960 indicated that a higher number of deaths from lung cancer occurred among uranium miners than would normally be expected. A follow-up study in 1974 verified these conclusions. Among the 779 Indians included in these studies, the observed rate of lung cancer was significantly higher than expected.<sup>30</sup> A 1980 study reported that 16 of 17 lung cancer cases diagnosed at the Shiprock Indian Hospital in New Mexico during the period from 1965 to 1979 had a history of uranium mining.<sup>31</sup> Today, this risk has been reduced as a result of the improvement in mining conditions and the establishment of exposure standards.

There is a risk associated with the uranium milling process but it is not as clearly defined as the risk for uranium miners. However, risk estimates have been developed utilizing radiation level measurements from existing mill tailings piles and assumed radiation levels from a representative or model mill.<sup>32</sup> According to these calculations, the radon emitted from an existing inactive tailings pile is estimated to result in an additional 1.3 deaths per year in the population living within 50 miles of the site, or 1.7 deaths/year for the entire regional population.<sup>33</sup> Milling operations throughout the U.S. are estimated to result in 0.09 premature deaths/year for the general population and 1.5 premature deaths/year among workers.<sup>34</sup>

Nuclear power plants, radioactive waste material, and radionuclides in water contribute little to the radiation exposure of the Indian population. Background levels of radiation, which have not been shown to pose a risk, exceed the exposure received as a result of these three sources of radiation.

## ■ RESPONSE TO RADIATION CONCERNS RELATED TO NUCLEAR RESOURCE DEVELOPMENT

### Radiation Guidelines, Standards, and Legislation

Initial concern over radiation effects on humans was limited to radiation workers. Radioactive fallout from nuclear detonations and an increasing awareness of medical uses of radiation as sources of hazards led to a change in thinking. In 1954, the National Committee on Radiation Protection and Measurements (NCRP) suggested that a radiation tolerance value be established. This was followed in 1956 by a recommendation of the National Academy of Sciences-National Research Council Committee on the Biological Effects of Atomic Radiation that the population's exposure to man-made radiation should be limited to less than 10 rems within the first 30 years of life.<sup>35</sup> This recommended ceiling was divided into 5 rems from medical procedures and 5 rems from exposure to nonmedical sources. The Federal Radiation Council (FRC) was established in 1959 and published its Radiation Protection Guide in 1960. The FRC excluded background and medical irradiation from its guide which recommended a dose of 5 rems as the 30 year limit for the average population exposure.<sup>36</sup>

The current whole body occupational radiation dose is limited to 3 rems in any calendar quarter. The accumulated occupational dose may not exceed an average of 5 rems for each year above the age of 18.<sup>37</sup> In the case of nuclear power plants, licensees are required to reduce exposure as far below the limit as is reasonably achievable. This is a concept known as ALARA.<sup>38</sup>

The PHS recommended a working level for uranium miners in 1957 based on the concentration of alpha radiation from the decay of radon daughters in uranium mines. At the same time suggestions for ventilation and instruments for monitoring air were made.<sup>39</sup> An American Standards Association standard was approved as a guide for radiation protection in uranium mines and mills in 1960. By 1967, the States of Colorado, New Mexico, Utah and Wyoming had regulations limiting radiation exposure. In 1967, the FRC issued a guidance recommending a maximum exposure of 12 WLM/yr. The Department of Labor (DOL) established an exposure standard of 3.6 WLM/yr. in the same year but it only applied to certain underground mines. In 1969, the Department of Interior published its rules and regulations in the Federal Register which called for a reduction of the uranium miner's annual exposure from 12 WLM to 4 WLM by January 2, 1971.<sup>40</sup> The FRC also published its Radiation Protection Guide in 1969 in which an exposure level of 4 WLM/yr. for all underground mines was recommended.<sup>41</sup> This exposure level remains in effect today.

The Uranium Mill Tailings Radiation Control Act of 1978, Public Law 95-604, requires the DOE to conduct remedial action for designated

inactive uranium processing sites in accordance with standards promulgated by the EPA for the cleanup of the sites and disposal of tailings. P.L. 95-604 further prescribes that the remedial action be completed within 7 years of the enactment of these standards.

These EPA standards, currently in draft form, limit the release of radon gas from disposed tailings to 2 picocuries per square meter per second, about twice the average of normal soils. These standards also require the cleanup of open land and buildings contaminated by tailings when the average radium concentration attributable to tailings exceeds 5 picocuries per gram, about three to five times the average of normal soil.<sup>42</sup> In addition, the standards restrict contamination of drinkable ground water and the degradation of all useful ground water and surface waters. The EPA estimates that implementation of these standards at the 25 designated sites could prevent about 2 premature deaths each year from radiation-induced lung cancer.<sup>43</sup> This will impact on the Indian population since five of these sites are located on Indian land.

The Safe Drinking Water Act, Public Law 93-523, provided for the establishment of drinking water regulations to replace the Public Health Service Drinking Water Standards of 1962. On June 24, 1977, the National Interim Primary Drinking Water Regulations (NIPDWR) became law. These regulations became the standards by which all public drinking water supplies are to be judged.

The provisions of the NIPDWR included criteria for sampling radionuclides and established a maximum contaminant level (MCL) of 15 picocuries per liter (pCi/l) for gross alpha activity including radium-226 but excluding radon and uranium. An MCL of 5 pCi/l for combined radium-226 and radium-228 was also established. No MCL has been established for uranium at this time although a value of 10 pCi/l is currently under consideration by the EPA.

Passage of the National Environmental Policy Act of 1969 resulted in the requirement that environmental assessments be prepared for all activities which may affect the environment. This resulted in the preparation of an environmental impact statement for each nuclear power plant by the NRC. In 1980, NRC prepared a final generic environmental impact statement on uranium milling. Included in these statements are the nature and extent of the environmental and health impacts of nuclear power plants and uranium milling operations from local, regional, and national perspectives on both long and short-term bases.

Nuclear power facilities, States, and local agencies are required to have radiological emergency response plans. As a result of the

Three Mile Island incident, NRC and the Federal Emergency Management Agency (FEMA), under existing responsibilities and the President's statement of December 7, 1979, prepared criteria for the preparation and evaluation of such plans.<sup>44</sup> These plans are prepared by the licensee and are tested, exercised, and reviewed prior to acceptance by NRC; and the plans of the States and local agencies are reviewed by an interagency regional committee prior to approval by FEMA.

### **Specific Actions Taken to Resolve Radiation Concerns**

Mining and Milling - Mine conditions have steadily improved since the 1950's. With the introduction of ventilation and other dust control measures, the average concentration of radon daughters in uranium mines has decreased resulting in a lower exposure to miners. However, a special study conducted by the Mine Enforcement and Safety Administration (MESA), now the Mine Safety and Health Administration (MSHA) of the DOL, from 1975 to 1977 concluded that uranium miner exposure was greater than reported in the records of mine operators.<sup>45</sup> This led to more stringent sampling and record keeping standards as well as revised safety and health standards for radiation and ventilation.

The MSHA has the responsibility for inspecting uranium mines. Inspections are made twice a year for surface mines and four times per year for underground mines. As a result of these inspections, it became apparent that current radiation exposure measuring techniques did not provide the accuracy needed. A personal dosimeter to measure radon daughter exposure has been under development for over 10 years. The French<sup>46</sup> have developed a personal alpha dosimeter but so far it has not been tested in this country and its reliability is questioned by MSHA. The Bureau of Mines is continuing its research on the development of a personal dosimeter for radon because personal dosimeters offer the best method to measure an individual's exposure to radon with some degree of reliability.

The responsibility for licensing and inspecting uranium mills rests with either the NRC or the State. Inspections are conducted annually to determine compliance with the provisions of the license on matters relating to radiation.

A major difference between uranium mines and mills deals with medical surveillance of workers. As part of the mill's license, urine bioassay and whole body testing for gamma emissions are required. However, no medical screening of any type is required for mine workers although it is a common practice of the industry to perform pre-employment physicals on their employees. A 1980 study by the National Institute of Occupational Safety and Health (NIOSH)

indicated the importance of medical surveillance of uranium workers and recommended the further evaluation and development of medical surveillance programs.<sup>47</sup>

Radiation standards are continually being assessed in order to ensure that they provide adequate protection to those potentially exposed. The current exposure standard for uranium miners of 4 WLM/yr. has been the subject of some debate. In order to determine if this standard provides adequate protection to the miner, NIOSH is currently conducting an extensive review of the issue.<sup>48</sup>

Mill Tailing Sites - Concern over the potential health hazards of inactive uranium mill tailings was expressed as early as 1965 when the IHS attempted to gather information about the piles from both States and Federal agencies. As a result, the PHS conducted environmental surveys of the Tuba City site in 1967,<sup>49</sup> Mexican Hat in 1969,<sup>50</sup> and Monument Valley in 1970.<sup>51</sup> A chemical stabilizer was applied to the Tuba City site in 1968 but by 1974 this was no longer effective. The Riverton site was fenced and covered with 1.5 feet of soil and gravel and the pit was lined with clay. In addition, a portion of the Shiprock pile was covered with soil and gravel and dikes were constructed to control wind erosion.

These activities were followed by gamma surveys conducted by the EPA from 1971-1974. Based on these surveys, the AEC and the EPA proposed to a congressional committee that a comprehensive study of all inactive uranium mill tailings sites be performed. An assessment of the physical conditions of the inactive uranium mill sites and preliminary engineering assessments followed. As a result, it was concluded that some form of remedial action was required to alleviate potential public health hazards at 25 sites, most of which were located in the Colorado plateau. P.L. 95-604 was the resultant legislation.

The objectives of the Inactive Uranium Mill Tailings Sites Remedial Action Program are to conduct radiological screening, aerial and ground radiological surveys, and engineering assessments of radiological conditions at the tailings sites and properties in the vicinity of these sites. With this information, remedial action requirements will be determined, plans and specifications developed for implementing the required action, and the necessary remedial actions performed.

Much of the work outlined has already been completed including the radiological screening<sup>52</sup> and the engineering assessments<sup>53</sup> at all sites. Based on these surveys and assessments, Shiprock and Riverton were given a high priority for remedial action, Tuba City

and Mexican Hat a medium priority and Monument Valley a low priority. Aerial surveys have been conducted at all sites except for Monument Valley which is scheduled for 1983. Ground surveys are complete at Shiprock and Mexican Hat and are scheduled for 1982 at Tuba City and Riverton and 1983 for Monument Valley.<sup>54</sup> The engineering assessments were updated in 1981 to reflect any physical changes at the sites and current costs for remedial action. An environmental impact statement is being prepared for Shiprock and environmental assessments will be prepared for the other sites.

While no final decision has yet been reached on what remedial action to take, the preferred method is to stabilize the waste material in place. According to the current schedule, remedial action is to begin at Shiprock in late 1984 and continue for 3 years. Riverton and Mexican Hat are both slated for remedial action in mid-1985 and will require more than 2 years to complete. Finally, Tuba City and Monument Valley are scheduled for 1986 and 3 years will be required to complete the work.<sup>55</sup> In the interim, discussions have been held between the community and the DOE about methods to limit access to the Tuba City site. A design for a fence has been prepared but no date has been set for its purchase and installation.

Water - The IHS, in cooperation with Indian tribes and the EPA, undertook the task of sampling 710 Indian-owned and operated community water systems which serve about 72% of all Indian homes on Indian land. This sampling is essentially complete but not all the results have been received.<sup>56</sup> A few water sources were found to have levels of gross alpha particle activity in excess of the 15 pCi/l standard. These systems are no longer in use or have been integrated into other systems resulting in water which does not exceed the standard. In one instance, the contaminating aquifer was sealed. The source of the radiation found is apparently of natural origin and is not the result of any mining or milling activity.

There are a number of water sources which have high levels of naturally occurring uranium and these are still in use. According to the EPA, an interim guidance level of 20 pCi/l for uranium may be used while exploring and taking remedial measures such as dilution or the location of a new source.<sup>57</sup> Continued monitoring is essential during this period and this is being done.

Current evidence on the effects of uranium in drinking water is not conclusive. However, working on the assumption that exposure to radiation should be minimized, the IHS has entered into an agreement with the EPA to test ion exchange units for uranium removal. The EPA has had success in a laboratory setting, but before proposing this as an effective method for uranium removal, a field test is necessary. Four such units will be provided and tested on the

Navajo Reservation. In addition, the IHS will continue to work with the tribes and the EPA to replace or modify water systems which cannot comply with the requirements of the NIPDWR.

Pine Ridge Studies - The Black Hills Alliance sampled four wells on the Pine Ridge Reservation in South Dakota and submitted these samples to a laboratory for analysis in February 1980. All four samples contained radionuclides, but in only one case was there any indication that the radiation standard for drinking water might be exceeded. Based on the presence of radiation in the water, the Women of All Red Nations claimed that this could explain an alleged increase in cancer, birth defects, and spontaneous abortions among Pine Ridge residents.

In response to this allegation, and in order to assure that the water used by Pine Ridge residents was safe to drink, the IHS instituted measures to investigate the charges. A program to sample all community water systems for radionuclides, as required by the NIPDWR, was accelerated for the systems on the Pine Ridge Reservation and the results compared with recognized national standards. In order to determine if the incidence of cancer, birth defects, and spontaneous abortions on the Pine Ridge Reservation exceeded what would normally be expected, the IHS invited the CDC, in cooperation with the Senior Epidemiologist of IHS, to do an indepth review of these three medical disorders.

As a result of the analysis of water samples from the Pine Ridge Reservation, it can be stated that the level of radioactivity present in the water does not exceed national standards and presents no danger to the people of the area. The epidemiological studies indicate that the incidence rates of cancer,<sup>58</sup> birth defects,<sup>59</sup> and spontaneous abortions<sup>60</sup> do not exceed the expected rates for the population studied. Furthermore, it can be concluded that the levels of radioactivity found in the water did not appear to have any impact on the incidence of cancer, birth defects, and spontaneous abortions.

Church Rock Spill - The tailings pond dam which broke and spilled radioactive liquid and solid wastes into the Rio Puerco near Church Rock, New Mexico in 1979 resulted in a concerted effort by the State of New Mexico, the EPA, the CDC, and the IHS to assess the effects of the spill on water and food. Evaluation of six Navajos potentially exposed to the materials spilled in the river showed them to have no detectable increase in radioactivity by whole-body count and no increase in urinary radionuclides.<sup>61</sup> The results of air, soil, and water sampling in connection with the failure of the tailings pond dam indicated that levels of radiation in the area, while high immediately after the spill, had returned to their

prespill levels. However, concentrations of radionuclides in edible tissue of local animals were found to be higher than that in control animals.

Even though the results of the analysis of animal tissue did not reveal radionuclide levels which would constitute a health hazard, CDC is still concerned that the discharge of water from uranium mining may contribute to the elevated levels of radionuclides found in animal tissue. Therefore, CDC suggested that additional studies be performed to clarify whether the radionuclide levels found were the result of mine dewatering effluent, mine radon releases, or natural background radiation.<sup>62</sup> Plans are presently being finalized by the Navajo Tribe and the IHS to conduct additional animal studies in conjunction with interested church groups, the State of New Mexico, and the EPA.

Education - The studies of uranium miners in the 1950's indicated that hazards were associated with this occupation. As a result of medical examinations and environmental monitoring of the mines, the miners were receiving information about the potential hazards of uranium mining. Additional information was being disseminated through the AEC and the State Health Departments of Colorado, Utah, Arizona, and New Mexico as well as the mining industry. A continued program of education and promotion of improved environmental controls was accelerated as a result of these studies.<sup>63</sup> In addition to information provided to miners by industry today, MSHA produces safety manuals which cover many aspects of mining and distributes them to miners. One such manual covers radiation.<sup>64</sup>

The IHS has continued the efforts to educate the Indian population about radiation and its effects. This is accomplished through meetings, consultation, training, and other activities conducted primarily by the Office of Environmental Health. These activities encompass not only radiation in water and the uranium industry, but also diagnostic and therapeutic radiation.

Several incidents which occurred on Indian land also provided the opportunity to discuss radiation and its effects. The use of mill tailings as building materials in residences in Cane Valley, Arizona led to a number of meetings with the community as well as individual contact through radiation surveys conducted at 17 residences. The Church Rock spill and the Pine Ridge studies afforded similar opportunities which were in addition to ongoing efforts.

The Americans for Indian Opportunity (AIO) is a non-profit organization concerned with issues which affect Indians. As a result of their concern about radiation and other impacts on the environment, AIO sponsored six seminars throughout the U.S. during

1980-1981. Funding for per diem and transportation was provided by several Federal agencies, including the HHS, so that each tribe could send representatives to the seminar held nearest their reservation. A publication entitled "Radiation and Its Health Effects" was prepared by AIO and distributed to tribal groups. Indian tribes and groups also are kept apprised of radiation issues as a result of the requirement that nuclear power facilities, States, and local agencies have, and exercise, radiological emergency plans.

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## ■ CONCLUSIONS

The average American receives about 0.2 rem of radiation exposure each year from natural and man-made radiation. This amount does not appear to represent a health hazard although it is generally accepted that even low doses of radiation exposure should be minimized. One way to reduce an individual's exposure from this source of radiation is to decrease one's exposure to medical x-rays. The Indian Health Service (IHS) accomplishes this through a variety of methods including x-ray compliance surveys of equipment, education of the technicians, more selective use of x-ray examinations, and the use of improved technology to decrease dose.

The mining conditions that existed in the 1950's contributed to the high radiation exposure experienced by uranium miners. Some of these miners, including Indians, have developed cancer as a result. Since that time, exposure standards have been established and mine conditions have been improved. The state of the art for the uranium mining industry is such that the exposures seen in workers in the 1950's are not likely to recur. However, until a personal dosimeter for radon is perfected, it will not be possible to measure a uranium miner's exposure with any degree of reliability.

The milling industry contributes radiation exposure to the worker as well as to the local and regional populations. Based on risk estimates developed for the industry, this exposure can be estimated to result in less than two premature deaths/year from cancer nationwide. While the risk associated with this exposure is small, further reductions may be possible by installing more strict emission controls, limiting the duration of exposure of workers, or by limiting the population that resides within 6 miles of the mill.

The nuclear power industry has been subject to close scrutiny from its inception. As a result, the safety record of the industry is one of the best when compared with other industries.

Radiation from abandoned uranium mill tailings may increase the exposure of individuals working on or living very near the tailings. In addition, wind erosion and unrestricted access to the tailings represent a potential exposure hazard to the population of the area. While radiation from abandoned uranium mill tailings has not been shown to be the cause of adverse health effects, the EPA has estimated that a small number of additional cancer deaths may occur as a result of the radon emitted from existing piles. P.L. 95-604, the Uranium Mill Tailings Radiation Control Act of 1978, is expected to address these concerns by reducing the amount of radon emitted from abandoned mill tailing piles to near background levels.

Studies and measurements of radiation in water have not implicated the mining and milling industry in contamination of the ground

water. However, some wells have shown contamination as a result of toxic substances from mill tailings and some migration of radionuclides and toxic substances through the soil has been observed. Current regulations for the industry and for water quality, as well as the action to be taken under P.L. 95-604, should be adequate to ensure that the quality of the ground water is not altered.

The public, including Indians, has heard about radiation but does not understand it. This lack of understanding occurs in part because radiation cannot be seen, felt or smelled. In addition, people tend to equate all radiation with the reported effects of radiation from the atom bombs dropped on Japan, and are confused by the contradictory statements of the pro and anti-nuclear forces. Because the subject of radiation has become such an emotional issue, the need exists to adequately inform the Indian population of the real and imagined health hazards related to nuclear resource development on Indian land.

The potential adverse health effects of radiation are a concern of the Indian people and the IHS. However, the risk of cancer developing from the radiation levels which exist as background, or in occupations related to the mining or milling of uranium, is extremely small. In addition, other health problems exist on Indian land which pose considerable more risk to the Indian population than radiation. Nevertheless, the IHS will continue to work with all government and private agencies with responsibility in radiation matters to ensure that legislation and regulations regarding radiation are properly implemented and monitored on Indian lands in order to reduce the level of radiation exposure to the worker and the general population.

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